THE INTRA-DAILY EXCHANGE RATE DYNAMICS AND MONETARY POLICIES AFTER THE G5 AGREEMENT

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SUMMARY

This paper investigates determinants of yen appreciation for the one-year period after the G5 (Plaza) agreement of September 1985. During that period, we may identify five waves of appreciation, each lasting two weeks to one month, separated by relatively calm periods. For each wave and calm period, the changes in the yen/dollar exchange rate are decomposed in those taken place in the Tokyo, Europe and New York markets. In addition, the correlations among the yen, mark, and pound, and the correlations between the yen/dollar exchange rate and the long-term interest rate differential for each market for each wave are studied. Determinants of each appreciation wave are identified by news and regression analyses.

The identified determinants included the U.S. policy switch (in the first wave), the Bank of Japan, "high interest rate" policy (in the second wave), and various mix of the sharp decline of oil prices and the decline of the U.S. interest rate (in the third, fourth, and fifth waves).

These findings are consistent with a view that the exchange rates respond mainly to news of fundamentals and that the exchange rates are not manageable by coordinated interventions alone.

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1. INTRODUCTION

This paper examines exchange rate dynamics after the much-hailed Group of Five (G5) Meeting of September 22, 1985, held in the Plaza Hotel, New York. Just before the G5 meeting, many policy makers as well as economists would have agreed that the U.S. dollar was overvalued. The only remaining question was how to bring about the dollar depreciation and how quickly it should be done. A one-year experience after the G5 agreement was a success in the sense that the dollar is depreciated significantly against major currencies; in particular depreciated by over 40% against the Japanese yen. Figure 1 shows the daily yen/$ exchange rate dynamics from September 19, 1985 to September 26, 1986.

FIGURE 1 ABOUT HERE

1.A FIVE WAVES

It is clear from Figure 1 that the exchange rate changes came in "waves." In a given wave, the yen appreciates by 10 or more yen in a matter of one week or two, then the exchange rate stays relatively calm for two weeks to two months until the next wave. This kind of alternating pattern of volatility is a common feature of exchange rate movements. (See Mussa (1979).)

A dramatic announcement at the end of G5 meeting, coupled with direct intervention and other measures taken by central banks, brought down the value of U.S. dollar very quickly. This was the first wave. The second wave in late October to mid-November was due to the action taken by the Bank of Japan. By December 1985, it appeared that coordinated interventions seemed to have worked very well, although there was no agreement to why it was so successful.

Some consider that the episode shows how effectively the government can manage the exchange rate by interventions and other (monetary) policies. Others, however, believe that the rapid depreciation of the dollar was essentially driven by market forces, pointing out that the dollar had been gradually slipping for seven months prior to the G5 big push. (See Feldstein (1986).) They contend that the government intervention was effective only because it was "leaning with the wind." If we take a position that government actions in a broad sense made a big difference, there still are questions. During the first three months after the G5 meeting, was it the Japanese side (the Ministry of Finance and Bank of Japan) which should be given responsibility, since the yen appreciated the most? Or, was it the United States team (the Treasury and the Fed) which made the difference this time?

The third wave of yen appreciation occured in late January. After this round, Japan became more and more hesitant to support further yen appreciation. As the yen appreciated to 175 yen/$ in the middle of March, the Bank of Japan started intervening again, but this time by buying dollars in order to prevent further yen appreciation. In Japan, this operation was nicknamed "reverse interventions." In the six months after the G5 meeting, the trade-weighted dollar depreciated more than 15%: the dollar depreciated more than 25% against the yen, about 20% against the German Mark, and 10% against the British pound. Apparently, the Japanese authorities thought this was enough. However, yen appreciated despite effort by the Japanese authorities through mid-May. This can be viewed as the fourth wave. The Tokyo summit in May did not yield any agreement on

an international monetary reform or a target zone for the exchange rates. It seemed that international coordination on the exchange rate management was once again in disarray. Major countries were unable to agree on whether or not the dollar had to further depreciate. After a brief period of yen depreciation, the last wave brought yen to the level of 154 yen/$ in August 1. For the rest of the year, the foreign exchange market had been relatively quiet. Admittedly, the fourth and fifth waves with the brief depreciation phase are less sharply distinctive as waves compared to other three episodes.

1.B News Analysis

In Sections 2 and 3, I will investigate the determinant of the exchange rates using intra-daily exchange rate and long-term interest rate data. First of all, "news" in this paper is a "surprise portion" in any announcement of policy changes or a economic development in the market. Lowering the discount rate by 0.5 percentage point is "not a news," if the change has been "expected" in the market. However, if the rate cut is 0.75 percentage point, while the expectation has been 0.5 percentage point, the difference, 0.25%, is a "news."

Since the foreign exchange market is a well-organized, highly efficient asset market, relevant information is processed and reflected upon exchange rates within minutes. Moreover, unlike the country-specific stock market or bond market, the foreign exchange market is practically open 24 hours Monday through Friday, somewhere in the world. A wave of appreciation should coincide with the arrival of a major news about the determinants (fundamentals) of the exchange rate. By matching economic and political news with a wave

of appreciation, we will be able to identify sources of exchange rate changes. However, for this purpose, daily exchange rate data are not "fine" enough. The exchange rate responds to news in a matter of minutes. For example, if relevant news, say Baker's testimony before a Congressional committee, originates in the United States, the exchange rate should change during the New York market sessions. By the time the New York market closes, the exchange rate is fully adjusted to news that became available during the day.

Time differences make it possible to identify the origin of news by looking at changes in respective markets. Since New York is 14 hours (13 hours during daylight saving time) behind Tokyo, business hours of the two countries do not overlap. Thus, it is safe to assume that exchange rate changes in the New York market primarily reflect U.S. news, while changes in the Tokyo market are primarily caused by the Japanese political and economic news. In sum, by looking at intra-daily movements of the exchange rate in different countries, good inferences on determinants of the exchange rate can be made. \1\

When the Tokyo market opens two and a half (three and a half, during the summer) hours after the New York closing, the Tokyo opening exchange rate reflects all the news up to that point. Any exchange rate changes during the Tokyo market reflect relevant news that becomes available during the Tokyo market hours. For example, if the Bank of Japan's policy change is responsible for the exchange rate movement, then the exchange rate changes in the Tokyo market where the Japanese monetary policy is revealed.

Let us summarize two basic assumptions of news analysis relevant in this paper. First, any news should be reflected by the change in

the prices within the period chosen for the time unit of analysis. Second, major news of one country's policy are announced within the business hours of the respective market.

There is little doubt that the first assumption is satisfied with respect to the foreign exchange and bond markets. The second assumption may be controversial, since a major news about country's policy sometimes breaks after the market in that country is closed. For example, President Reagan or Prime Minister Nakasone may conduct a press conference or make a TV appearance after market hours. Finance Minister or Treasury Secretary could make an important remark when they are travelling abroad. If there are notable exceptions, I will mention them in the text. However, these exceptions, i.e., mismatch of news origin and market response, are not frequent.

Economists, who do not know exactly what are relevant fundamentals (determinants), can look at the exchange rate changes in various markets within the day, and match them with the arrival of news, in order to obtain an important insight on the exchange rate dynamics.

1.C Definition

In this paper, the daily exchange rate change is decomposed into the changes in the Tokyo market, the European market, and the New York market. Figure 2 depicts how major markets in the world overlap each other. We divide changes in the exchange rate in day t, into three representative market with the following definitions:

\2\

Definitions of "Changes in the market"

Tokyo (t) = [Tokyo closing (t)] - [New York closing (t-1)]

Europe (t) = [New York opening (t)] - [Tokyo closing (t)]

New York (t) = [New York closing (t)] - [New York opening (t)]

FIGURE 2 ABOUT HERE

The above definitions are not as precise as one could hope for. First, because of the overlap of the afternoon hours of the European market and the early morning hours of the New York market, anything that happens in the London market after 3 pm is attributed to U.S. news, while anything that occurs in the New York market before 9 am is attributed to European news. In particular, some U.S. economic indicator announcements, including the producer price and industrial production indices occur at 8:30 am, before the New York foreign exchange market opens. Second, as explained above as exceptions to the second basic assumption of news analysis, occasional political developments take place after the foreign exchange market closes in that country. Hence the correspondence between the timing of news announcements and market hours is not always perfect. However, as a first approximation, this market decomposition of the exchange rate movements gives us an initial important sign of the origins of exchange rate disturbance. An investigation of market-specific changes will provide us with a foundation for exploring determination of the exchange rates.

1.D. The Model, Regression

The usual signs in covariances between the various exchange rates and between the exchange rate and other economic variables are implicitly assumed, although I will not present a formal theoretical model of exchange rate determination in this paper. In particular, the following theoretical predictions are taken for granted.

Institutional investors are assumed to behave in accordance with

a standard portfolio balance model. (See, for example, Frankel (1983).) Therefore, an increase in the interest rate in a country would cause its currency to appreciate against other currencies.

We also expect that if the oil price declines, then the pound, the currency of a major oil producer, should depreciate, while yen, the currency of a major oil importer, should appreciate.

In order to test these theoretical predictions, news analysis, correlation analysis and a regression analysis will be employed.

News analysis, as explained above, concentrates on the change in the yen/dollar exchange rate in various markets. A contribution of various markets toward overall changes will be interpreted as a geographical source of disturbances. Matching major economic and politicl events in the country where major movement occured will reveal the source of the exchange rate movements.

A simple correlation table between the Japanese yen, the German mark and the British pound will reveal a lot of information about the economic source of major disturbances in the foreign exchange market. For example, if the yen appreciates because of the U.S. policy changes, then yen movements would be closely correlated with the mark and pound movements. If oil is the major source of disturbances, the correlation between yen and pound would be negative.

Finally, a usual regression analysis will complement news analysis and correlation analysis, which provide ample evidence about the determinants of exchange rate changes. The regressions analysis in this paper plays only a complementary role, due to the reasons which I emphasized above in explaining why news analysis is more appropriate. For example, if the exchange rate responds to "news" of

expected changes in the monetary policy stance, the regression of the exchange rate on the interest rate would not reveal the causality.

The next section analyzes exchange rate movements, in particular causes behind five waves of yen appreciations from the G5 meeting of September 1985 to September 1986. In the third section, regressions analysis will be carried out to quantify the effects of the interest rate on the exchange rate. We will find that each appreciation wave is explained as the exchange rate responses to changes, or signals of upcoming changes, in "fundamentals." Implications of these findings will be discussed in the concluding remarks.

2. FIVE WAVES OF YEN APPRECIATION

Let us first prepare some tools for analyzing the determinants of waves of yen appreciation.

As shown in Figure 1, the eight-month period after the G5 meeting can be divided into five waves of yen appreciations with quiet periods and one brief depreciation period separating the waves.

Table 1 shows the decomposition of (level) changes in the yen/$ exchange rate into the Tokyo, European and New York markets for each wave and for the periods in between. Table 2 shows correlation among the changes of the three currencies in each market for each subperiod.

TABLES 1 and 2 ABOUT HERE

Most modern theories of the exchange rate determination emphasize the relation between the long-term interest rate and the exchange rate. The overvalued dollar problem from 1981 to 1985 was often blamed on the U.S. government deficits which created unusually

high yield for the government bonds. If long-term capital flows are important factor in determining the yen/$ exchange rate, as has been suggested by many researcher, we should expect to see that the yen/$ exchange rate moves closely with the difference in the yen- and dollar-denominated interest rates.

Figure 3 shows the exchange rate movement (repeating Figure 1) by a solid line (with the left scale) and the difference between the Japanese and the U.S. long-term government bond yields by a broken line (with the right scale) for the one-year period after the G5 meeting. It is immediately clear that the interest rate differential movement and yen appreciation over the one-year period generally confirms what the portfolio-balance or monetary theory would predict. That is, as the difference between the interest rate narrows, the portfolio shifts back to the yen-denominated bonds, thus creating yen appreciation. A close examination, however, reveals that the relationship between the interest rate differential and the exchange rate varies for different waves of yen appreciation.

FIGURE 3 ABOUT HERE

A. The G5 weekend

The G5 emergency meeting was hastily put together on the weekend of September 21, 1985. At the time of closing in the New York market on September 20, Friday, it was known that the meeting would take place but there was no suspicion that anything big would come out of it. At the closing of the New York market on the Fridey, the yen/dollar rate was 239, little changed from the day before.

The G5 agreement, also known as the Plaza agreement, that the participants will take coordinated actions to depreciate the U.S.

dollar, was announced during the weekend. When the first market, New Zealand's Wellington market, opened on September 23, Monday, the yen appreciated by 5 yen to 234 yen/$. \3\ The Tokyo market, which would have opened next, was closed for a national holiday. The London market put 232 yen/$, and appreciation continued during the New York market session, opening at 231 and closing at 225.5 yen/$. By the time the Tokyo market opened on September 24, yen had already appreciated by more than 10 yen. The Tokyo market opened at 229.7 and closed at 230.1, while the Bank of Japan reportedly sold 1.3 billion dollars. It was only after the big jump had already taken place that the Bank of Japan started a heavy intervention, and the intervention did not seem to cause yen appreciation. (It, however, is possible to say that it prevented a sharp rebound.) Thus, the Bank of Japan's role in the yen appreciation should be minimal at this stage. It is safe to say that the initial jump was caused by the "announcement" itself.

What was new in the announcement then? In answering this question, it is useful to investigate what happened one week following the announcement.

B. First Wave: September 23 to September 30, 1985

Reading statistics of the first wave (September 23- September 30) in Table 1 (row I), we notice that 85% (=12.675/14.95) of the yen appreciation during the week took place in the New York market. During the week, central banks of the G5 countries sold U.S. dollars, as agreed upon in the G5 meeting. It is reported that the amount of intervention accumulated in this week by the Bank of Japan surpassed that of the Federal Reserve Bank of New York. However, the fact that

the yen appreciation was concentrated in the New York market rather than the Tokyo market suggests that the most important factor for the appreciation was not the Bank of Japan's intervention but news in the New York market. Although the Federal Reserve Bank of New York could intervene on behalf of the Bank of Japan [Itaku Kainyu] or any other central banks, the account that non-U.S. central banks have with the Federal Reseve Bank of New York show little suspicious movement around late September 1985.

In Table 2 (row I), we see that correlations among the yen, mark and pound in the New York market during the week of first wave are uniformly very high. This also suggests that the dollar was the major source of disturbances and the rest of the currencies moved together against the dollar.

Figure 3 shows that the interest rate differential was not the factor of exchange rate movement in the week following the G5 agreement.

This is consistent with a view that a most important aspect of the G5 meeting was the change in the U.S. position from benign neglect to international coordination. During the Regan-Sprinkel regime, the Treasury Department took a position that the dollar was strong because of the strong U.S. economy. They denied a link between the U.S. fiscal deficit and high interest rates or a link between high U.S. interest rates and the strong dollar. Under the Baker regime, a need for greater international coordination was expressed and manifested itself in to the G5 agreement. It was a "surprise" (news) for the market that the Fed intervened in cooperation with other central banks, although the amount of Fed interven-

tion was less then the Bank of Japan's at this point.

The market must have been more and more conviced of the U.S. policy change in the New York market everyday.

C. Second Wave:

During the first three weeks of October, the yen was stabilized at the 214 - 218 range. In fact, from TABLE 1, (the Q row between waves I and II) we know that the yen slightly depreciated, with all the depreciation taking place in Tokyo, while it appreciated in the other markets.

At this point, many market participants were expecting that the dollar might become strong again. Especially when the Seoul Meeting of Finance ministers at the occasion of the IMF meeting (weekend of October 5) did not produce any follow-up to the Plaza G5, some market participants expressed an opinion that the dollar had hit bottom.

In fact, the exchange rate expectation survey taken among the market participants on October 16 in the Tokyo market confirms this point. The mean of the survey shows that yen rate would be 214 in one month, 217 in 3 months, and 222 in 6 months. (For the nature of the survey, see Ito (1987).)

However, the Japanese authorities judged that the amount of yen appreciation was not enough and feared that the dollar might creep up to its previous level. Facing with a conflicting market expectation, the Bank of Japan decided to take a stronger action.

The Bank of Japan announced a major policy change on October 24, Thursday. Governor Sumita in a regular press conference announced that the Bank would adopt a high short-term interest rate policy. The presumption was that narrowing the interest rate gap between the

U.S. and Japan would create another round of yen appreciation.

The market, however, did not respond on the day of announcement. After Sumita's announcement which came in the middle of afternoon, the exchange rate hardly changed in the Tokyo market or in the New York market: the Tokyo market opening was 215.85 and its closing was 215.65; then the New York market opening was 216.90 and its closing was 216.37.

On October 25, the Tokyo market opened at 216.55. Yen appreciation took off from there. As the short-term interest rate soared in the morning trading, the yen appreciated sharply. The Tokyo closing rate of the day was 214.90.

It is quite interesting from the scholarly point of view that the market missed the "cue" and did not act for more than 18 hours after Sumita's announcement. This shows that either the Bank of Japan's announcement was not credible or market participants were not rational enough.

Yen appreciation continued for two weeks, as more and more market participants became convinced about the new monetary policy. In fact, FIGURE 3 shows how closely narrowing the interest rate differential (mainly due to the increase in the Japanese long-term interest rate) coincide with yen appreciation during this wave.

During this wave, most of the yen appreciation occured in the Tokyo market -- in contrast to the first wave. TABLE 1 (row II) shows that 72% (=7.7/10.745) of the appreciation took place in Tokyo. This suggests that new information became available in the Tokyo market. As the short-term interest rate rises in Tokyo, yen became appreciated in the Tokyo market.

The Tokyo market in the second wave in TABLE 2 shows that the

correlation between the yen and the mark was low and so was the correlation between the yen and the pound. In contrast, the mark-pound correlation was higher, implying that the relative values between mark and pound stayed constant. The correlation table is an evidence that a major disturbance occured with regard to yen against the other currencies in the second wave of yen appreciation.

These facts suggest a senario that the second wave was caused by the Bank of Japan's monetary policy alone.

D. The regime of 200 yen/$

After the second wave of yen appreciation, the yen hovered just above 200 for more than two and half months. Was it so calm because of a lack of major news?

It seemed that there was as much potential news as in any other periods. The high interest rate policy, which caused the second wave, was gradually eased and formally abandoned on December 17. (The three-month Tegata interest rate peaked on November 19, the one-month Tegata rate p... ...n December 13.) The discount rate cut by the Bank of Japan, which did not take place until January 30, was rumored as early as December 20. These developments might have put pressure on the yen to depreciate, especially after the middle of December.

The OPEC countries announced after the December 8 meeting that it had decided to defend their market shares even if it meant lower oil prices. The German mark appreciated about 7.8% from November 7 to January 24, while the British pound depreciated about 1.3 % during the same period. The pound depreciation seemed to have been caused by the decline in crude oil prices. As Japan is a major oil importer, it would not have been surprising if yen had appreciated during

the same period. In other words, it looked rather "artificial" that the yen/$ value is fixed, while German mark and British pound against dollar moved around. (In TABLE 2, the same point can also be seen as very low correlations between the yen and the mark, and between the yen and the pound in the Tokyo market for the period between November 8 to January 23.)

FIGURE 3 gives another look at the puzzle in this period. Although the second wave was initiated by narrowing the interest rate differential (by raising the Japanese long-term interest rate), a correction of "over-shooting" of interest rate differential(i.e., widening of the differential) did not cause the exchange rate to move. If the interest rate differential was a powerful weapon to change the course of the exchange rate from late October to mid-November, why did the exchange rate stay calm when the interest rate differential fluctuate during the rest of November and December?

There are two possible explanations for the apparent stability of the yen/$ exchange rate from the beginning of November to the end of January. The first hypothesis is that as the high interest rate policy was gradually lifted, the yen received pressure to depreciate, while the oil price decline worked in the opposite direction. The two conflicting pressures may have happened to have an equal magnitude.

The second hypothesis is that the Japanese monetary authorities made an attempt to stabilize the yen at around 200. The decision might have been made in early November. The interest rate policy was adjusted so that the exchange rate level could be sustained. That is why the Japanese interest rate continued to climb until late November

and then turned around and gradually came down until late January, while the exchange rate was essentially constant. There must have been a constant pressure on the yen to appreciate since the OPEC meeting of December 8, which was only mitigated by the interest rate decline. (One-month Tegata rate was 8.1875% on December 17 and 7.000% on January 23.) However, by January 24, the Japanese monetary authorities must have decided that it would be difficult to maintain the 200 yen/$ rate (without a drastic cut in the interest rate).

I think that the latter explanation, i.e., the policy target explanation, is more plausible. There were two episodes which reinforce this view. First, during the Japanese New Years holidays (the Tokyo market closes from the January 1 to January 3), the yen sneaked to appreciate in the New York market. On January 2, the yen closed at 198.55 in the New York market, breaking the 200 target level. Then news came from Japan. Governor Sumita of the Bank of Japan gave a New Years press interview that the yen should be kept around at 200. As soon as the news is relayed to the New York market on January 3, the yen level went back above the 200 level.

Second, what happened on January 24 is another proof for a hypothesis that the Japanese authorities tried to keep a target for the yen/dollar exchange rate. Finance Minister Takeshita was in Washington D.C. on his way home from the London G5 meeting of January 18 and 19. At a press conference in the United States, he reportedly said that he would allow the yen to go below the 200 level. The Tokyo market was informed of Takeshita's remark by a news wire at around 3pm, thirty minutes to the closing of the market. The yen jumped from 201 to 198 in the matter of 20 minutes, then profit taking brought it back to 199.50 at the closing (3:30pm). Finance

Minister Takeshita came home that evening, long after the Tokyo market was closed, and gave another news conference in Tokyo. He said "if the exchange rate becomes in the 190s as a natural result of the market movement, it should not be artificially brought back (to more than 200). Though it varies depending on sectors, the 190s would be acceptable by the industries." (Literal translation from Nihon Keizai Shinbun, January 25, 1986.) This news conference in Tokyo was in turn reported in the European and New York markets which were still open.[4] The yen jumped to 198 in the London market and then 196.60 by the closing of the New York market.

E. Third Wave (January 24 - February 19)

A steep yen appreciation of 21 yen (10%) followed within four weeks after the Takeshita announcement. A long-expected discount rate cut by the Bank of Japan effective on January 30 (which was announced on January 29) did not stop the strength of the appreciation.

A major cause of the yen appreciation in this wave was the rapid oil price decline. A minor role was played by the decline in the U.S. long-term interest rate which reflected a U.S. fiscal policy switch. I have two kinds of evidence for this view.

First, Table 1 (row III) reveals that yen appreciation in this period took place almost equally in the three markets. What is interesting is that the contribution of the European market in this wave is very large compared to the other periods. Recall that the first wave of appreciation was attributed to the U.S. policy shift in favor of international coordination and the second wave was to Japanese monetary policy. What is new about the third wave is that the yen is appreciated in the European market, too. Why would the

yen, which is a third-country currency, appreciate in the European market? The answer becomes evident if one recognizes that significant developments on oil prices occur after the Tokyo market closes and before the New York market opens. Major news on oil include decisions on oil production and pricing by the OPEC countries, and the important spot market prices in the Netherlands and London.

Second, Table 2 (row III) reveals the correlation between the yen and the pound became very low in this period. Great Britain as a major exporter of oil, suffers from oil price declines so that its currency tends to decline in value. While Japan, as the largest oil importer, benefits so its currency tends to appreciate. Therefore, the low correlation between the two currencies makes us suspect that oil prices were a big factor, but not the only factor. (If oil is the only cause, then the correlation between yen and pound should be negative and close to -1.)

The yen continuously appreciated, while oil prices steadily declined. Although the pound appreciated over the period in question, its movement was not consistent. It seems that there was a mix of pound depreciation news (oil price decline) and appreciation news (something else). In this period, what might make the dollar depreciate (the pound to appreciate)?

One possible source of pound appreciation (dollar depreciation) pressure was a gradual change in the market's perception of the chance of reducing the U.S. government budget deficit. The huge budget deficits in the past several years are often blamed for creating U.S. high interest rates and, in turn, a strong dollar. In the first four months of 1986, perceptions about future deficits seem to

have changed drastically.[5] By the beginning of April, Japanese security firms, which had been purchasing U.S. long-term bonds, were reported to have cut back dramatically on security investments.[6]

In order to document this, let us turn to FIGURE 3. The long-term interest rate differential narrowed substantially (from 3.6 percentage point to 2.6 percentage point) roughly at the same time with the third wave. However, note the timing of a decline in the interest rate differential. The decline in the differential, which was mainly caused by the U.S. interest rate drop unlike the preceding wave, started clearly after the Takeshita announcement of January 24.

Thus, it is fair to summarize that the third wave seemed to have been triggered by Takeshita's remark on January 24. However, the third wave was partly because of an over-due effect of oil price declines (which preceded January 24) and partly because of narrowing the interest rate differential (which started after January 24).

F. "Reverse Intervention" by the Bank of Japan

As the third wave brought the yen into the 180's, the Japanese monetary authorities became resistant to further yen appreciation. The Bank of Japan started mentioning the possibility of intervention in support of the dollar (sell yen and buy dollars), a total reversal of the direction. Thus it is dubbed as a "reverse intervention" (Gyaku Kainyu) in Japan. (The earliest headline about its possibility appeared on February 4, when the yen was about to go under 190.) The actual reverse intervention did not come until March 18 when yen hit below the 175 yen/$ level.

During the interval between the third and fourth wave, there was a notable development. On March 6 and 7, France, Germany, Japan, and

the United States cut their discount rates by 0.5%. This was the first "coordinated" discount rate cut, which would theoretically achieve aggregate demand expansions, with a neutral impact on international capital flows (by keeping the interest rate differential intact).[7] However, right after the coordinated interest rate cut, the yen appreciated suddenly, which led to the reverse intervention of March 18 by the Bank of Japan. The yen appreciated from 179 (on the day of the discount rate cut announcement) to 174.90 eleven days later, which was turned around quickly and returned to the 180 level in a week. In that sense, a coordinated interest rate cut was successful in keeping the exchange rate stable, although with a quick fall and rise immediately following the rate cut.

G. Fourth Wave (April 16 - May 12)

The fourth wave started when the (second) internationally-coordinated discount rate cut became a certainty.[8] From April 16 to May 12, the yen appreciated by more than 17 yen, breaking the all-time high on April 21 in Tokyo. The monetary authorities in Japan did not want to cause further appreciation of yen. Short-term interest rates went down quickly and reverse intervention continued.

Table 1 (row IV) indicates that most appreciation took place in Tokyo and New York. Looking at Table 2 (row IV), we see that correlations between the three currencies were quite high. Not only the yen, but the pound and mark appreciated at the same time. In fact, at the peak of appreciation, April 28, the German central bank joined the Bank of Japan in intervening the market in order to support the dollar.

This evidence points to United States monetary policy as a main

cause of the fourth wave of yen appreciation. The fact that the United States was a leading advocate of the discount cut this time reinforces this view. The market participants must have figured out that despite the appearance of a "coordinated" discount rate cut, it is more likely to have a larger impact on U.S. (long-term) interest rates than on rates in other countries.

What about other factors? Since the decline of oil prices had stopped by the middle of April, oil was not the [illegible]tor. This is confirmed by relatively high correlations between the pound and yen (at least in Tokyo), and the pound and mark. There may have been some political speculation about a major international monetary reform to be discussed at the coming Tokyo summit. However, it would be hard to quantify what dealers expected about the monetary reform and how the outcome (no explicit agreement on a monetary reform) affected the foreign exchange market.

The long-term interest rate differential behavior shown in FIGURE 3 was interesting before and during the fourth wave. During the month of April, the long-term interest rate differential continuted to decline without apparent reaction in the yen/$ exchange rate. Just when the exchange rate started the fourth wave, the interest rate differential started widening again, mainly because of a reaction by the Bank of Japan mentioned above. Thus, it appears that the interest rate movement was not the factor for the fourth wave.

H. The Tokyo Summit and its aftermath -- a period of reversal --

The Tokyo Summit, held from May 4 to 6, yielded little progress on the front of international monetary coordination. Japan reported-

ly sought coordinated intervention to prevent the yen from further appreciation, which was rejected by the United States. Instead, a multilateral surveillance of macroeconomic indicators was proposed by the United States. The final agreement states that (i) G5 will be expanded to G7 to include Canada and Italy; (ii) Finance ministers and central bankers of the G7 countries will conduct "multilateral surveilance to make their best efforts to reach an understanding on appropriate remedial measures whenever there are significant deviations from an intended course and recommend that remedial efforts focus first and foremost on underlying policy fundamentals, while reaffirming the 1983 Williamsburg commitment to intervene in exchange markets when to do so would be helpful."

In Tokyo, this agreement was perceived as a measure not particularly helpful in relieving the pressure on the yen to appreciate. The agreement gave the impression that Japan's wish to stop further yen appreciation was unwelcomed by others, and that Japan had become "isolated." In particular, the Bank of Japan, which was almost alone in intervening in support of the dollar (selling yen), became more vulnerable to speculative attacks. The yen appreciated by about 10 yen (or 5.9%), to 160 in one week following the summit (which defined the end of the fourth wave).

However, the yen quickly turned around and started depreciating to its level before the summit and then up to the level almost cancelling the amount of the fourth wave. In fact, from May 13 to June 2, yen depreciated more than 11 yen.

Some people attribute the turnaround to the Treasury Secretary Baker's testimony in Congress on May 13 to the effect that he thought the yen had appreciated enough.

This short spell of quick appreciation and depreciation following the summit might have been a rare occasion of a speculative bubble forming and popping. First, there was no major economic news. Oil prices were stable, and major currencies were moving together (see TABLE 2, the last row.) Second, although the correlations with the yen were high, the amount of appreciation in the mark and pound in the week after the summit was much smaller than the yen: 1.8% for the mark and pound. Third, the depreciation was as quick as the appreciation and the yen came back to where it was. If it was a bubble, it would not be surprising that the bubble was burst by the Treasury Secretary Baker's testimony.

The summit agreement could be seen as a step toward international coordination of macroeconomic policies. Of course, how much can be achieved by "surveillance" remains to be seen. It is ironic that Japan and Germany, which in the past few years have sought macroeconomic coordination (i.e., lowering the U.S. interest rates) wanted to set an exchange target zone and coordinated intervention; and the United States, which had been unsympathetic toward policy coordination in the past summit meetings, turned around and proposed coordination. If one recognizes that intervention without fundamental policy changes is destined to fail, it is difficult to understand why Japan wanted coordinated intervention.

Even more ironic in March was that the coordinated discount rate cut was not put forward by Japan but by the United States. It was the United States that almost attempted a unilateral discount rate cut (thanks to a power struggle), while Japan which theoretically would prefer a unilateral interest rate cut to prevent further yen

appreciation, did not initiate an interest cut or go for a larger cut. Instead, Japan pursued unsuccessful intervention.

J. Fifth Wave (From June 3 to July 31)

A long and gradual yen appreciation took place in the early part of summer. Since appreciation during this period is much more gradual than other waves, it may be inappropriate to talk in the same manner with others.

Yen appreciated uniformly in three markets. A large effect in the European market in TABLE 1 and a low correlation between yen and pound shown in TABLE 2 suggest an effect from oil prices decline as was the case in the third wave. FIGURE 3 also shows that the interest rate differential played some role.

In sum, this final wave was caused by a mix of oil prices decline and narrowing of the long-term interest rate differential.

Yen reached the level of 154 yen/$ on August 1, and then stayed in the very close range until the end of sample period of this paper.

3. Regression Analysis

In the preceding section, determinants of exchange rate changes were inferred from the intra-daily exchange rate movements. In this section, a regression analysis is conducted to investigate the magnitude of effects from suspected determinants to the exchange rate.

Table 3 shows the response in the yen/$ exchange rate in the New York market (9:15am to 4:30pm) to changes in the long-term interest rate, the stock prices (S&P 500) and the oil prices. The interest rate is observed in almost at the same hours with the exchange rate. However, the oil prices and stock price index observations come only daily. Therefore the one-business-day percentage change is used for

those variables. The adjusted R squared is very low, but it is a common feature to this type of regression where the left had side variable is very close to, but not quite, a random walk. (According to Hakkio (1986), any tests of the random walk hypothesis has little power so that the acceptance of the null hypothesis does not imply that the actual process is a random walk.)

When the exchange rate is regressed on one of the three variables, the only variable which has a strong effect on the exchange rate within the day is the long-term interest rate. When the U.S. long-term interest rate decline by 100 basis point, yen depreciates 0.9 percent (e.g., 200 yen to 198) within the same day. However, this does not seem to be a very strong effect.

When all three variables are used, the long-term interest rate remains barely significant with a smaller coefficient. However, this equation may suffer from the multicollinearity between the long-term interest rate and the stock price indexes. Suppose that the monetary policy is the driving force, i.e., (news on) the monetary tightening or relaxing is the source of shocks. Then both the long-term interest rate and stock prices will move (in the opposite direction) at the same time.

The similar regression was tried in the Tokyo market without finding any significant variables. The effect of the Japanese interest rate on the exchange rate seems to be much weaker than the U.S. counterpart.

The result from this direct test is not conclusive. Although the effect from the interest rate to the exchange rate was confirmed, the magnitude was small for a possible conclusion that the interest

rate differential was the major determinant of the exchange rate.

Considering the explanations given in Section 2, there are reasons to suspect that the relationship between the exchange rate and "fundamentals" may have been changing over the year. In order to see the (in)stability of the coefficients, separate regressions were run with the U.S. interest rate changes on the right hand side for various waves and quiet periods separating waves as identified in Section 1. It shows that the influence of interest rate declined overtime. For example, the 100 basis point drop in the U.S. long-term interest rate in New York had an effect of 6 percent yen appreciation (e.g., 240 yen/$ to 225 yen) during the first month after the G5 of September 1985. During the 200 yen regime from November 1985 to January 1986, the 100 basis point drop in the U.S. interest rate meant only 1.3 percent appreciation of yen (200 yen to 197.4 yen).

The regressions result also shows that during the yen appreciation waves (possibly except the fifth one), the interest rate was not a major cause of yen movement, while during the quiet period, the coefficient is large and significant. This indicates that sharp appreciation of yen is often caused by news other than pure U.S. financial effects.

4. Concluding Remarks

The success of quick depreciation of the U.S. dollar during the week following the G5 agreement gave to some observers the impression that if coordinated interventions are made, it is possible to manage the exchange rate.\9\ However, as argued in this paper, intervention itself has played only a minor role in a period immediately following the G5 meeting. The U.S. policy changes signaled by Fed interventions were more important in changing market participants' perceptions about the fundamentals in the future. Interventions do not seem to cause a large change in the exchange rate levels, unless they are also signals of policy switch or a change in domestic policies. Especially the so-called "reverse intervention" by the Bank of Japan intended to stop "too much" yen appreciation after March 1986 was not successful, because it was not accompanied by the change in unilateral discount rate change or in stimulating the Japanese domestic economy. However, this conclusion does not rule out the possibility of "smoothing out" fluctuations by interventions.

Time to time, the exchange rate appears to respond to what Chairman Volker or the Finance Minister Takeshita says. These episodes might give an impression that a mere talk could "manage" or mismanage the foreign exchange market.\10\ However, as discussed in the preceding section, it is only under special circumstances that announcements of government officials have strong effects. Governor Sumita's press interview and Finance Minister Takeshita's remark were effective only because Japanese authorities consciously pursued a policy of targeting the 200 yen/dollar, the former confirming the policy and the latter signaling its abondanment.

Detailed investigations in this paper using intra-daily data

reveal that the large changes in the yen/dollar exchange rate levels after the G5 agreement were not "managed" by the U.S. and Japanese monetary authorities. This paper found that five waves of yen appreciation were, respectively, cause by the U.S. policy switch, the high interest rate policy by the Bank of Japan, the decline in oil prices, and a mix of prospects of U.S. fiscal deficit reduction and a further decline in oil prices. In other words, the exchange rates respond to news on what we consider "fundamentals" and not to mere interventions of the monetary authorities.

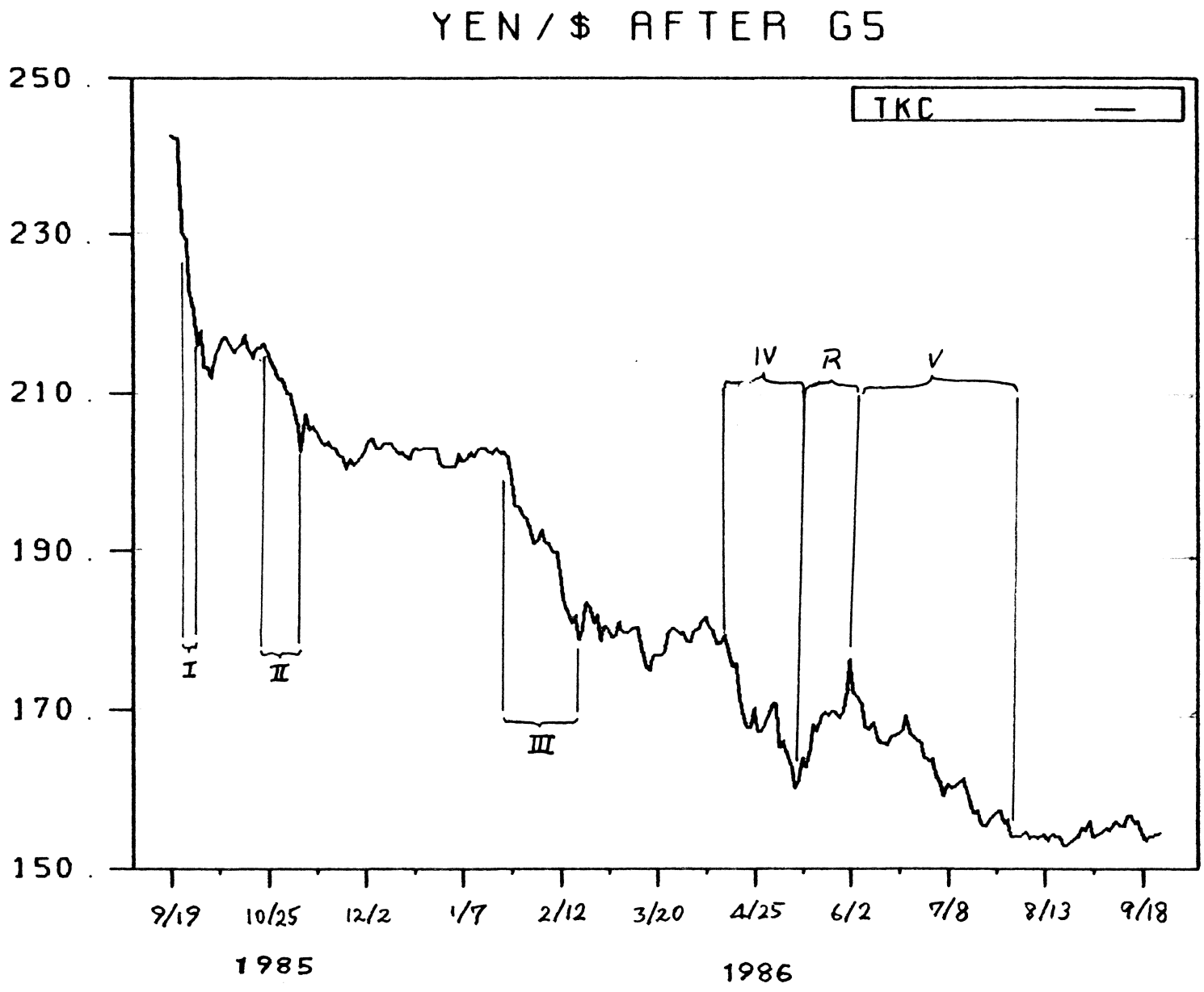
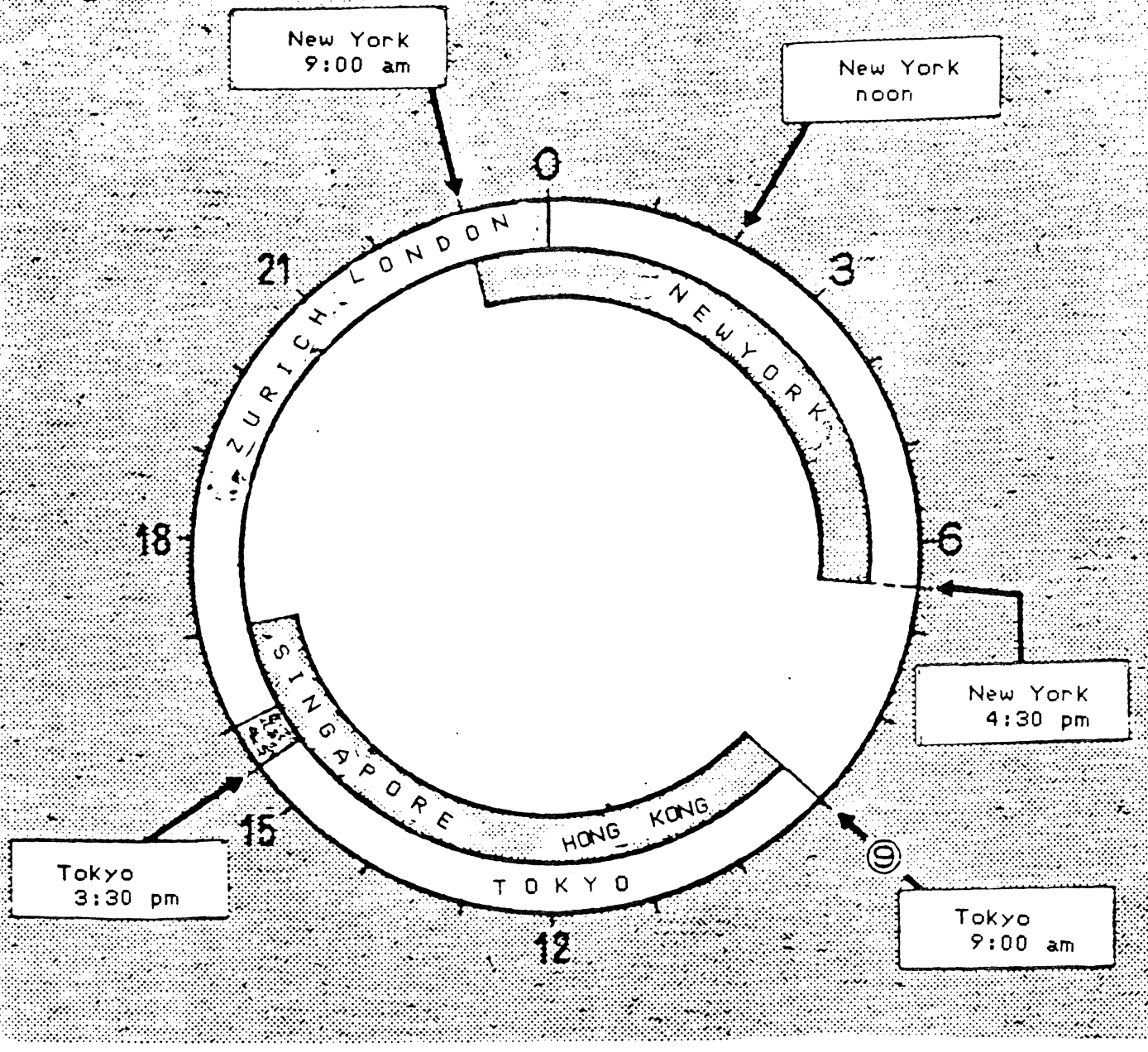

YEN/$ AFTER G5
TKC
250
230
210
190
170
150
I
II
III
IV
R
V
9/19
10/25
12/2
1/7
2/12
3/20
4/25
6/2
7/8
8/13
9/18
1985
1986

FIGURE 1

FIGURE 2

Major Market Hours in 24-hour Clock (Tokyo time)



Note: Daylight saving time is observed from the end of April to the end of October in New York. During that time, the New York market hours should be shifted by one hour counter-clockwise.

Data Appendix

The definition of data used in the paper is summarized as follows:

TKO (t) = the openning (9am) yen/$ in Tokyo at date t.

TKC (t) = the closing (3:30pm) yen/$ in Tokyo at date t.

NYO (t) = the openning (9am) yen/$ in New York at date t.

NYC (t) = the closing (4:30pm, or later if market is active) yen/$ in New York at date t.

In Tokyo, the interbank foreign exchange market is restricted to start at 9am and end at 3:30 with a lunch break from 12 noon to 1:30 pm. The screen goes blank right at the end of morning session and afternoon session. Thus, the openning and closing rates are well defined in Tokyo. In New York, the market hours are not well-defined, but the openning and closing time are defined from convention. The Tokyo rates are the transactions rate, while the New York rates are the simple average of bid and ask rates. The data in Tokyo are daily collected from Nihon Keizai Shinbun. The data in New York are given by the Federal Researve Bank of New York.

C>

TABLE 1

Decomposition of the Yen/$ Changes

Regime	Dates	Total change	Accumulated Yen Changes: Decompositions into market of Tokyo	Europe	New York
G5	Sep. 20 - Sep. 23	-7.75	(Tokyo closed)		-7.75
I	Sep. 23 - Sep. 30	-14.95	-0.85	-1.425	-12.675
Q	Oct. 1 - Oct. 24	0.12	4.225	-1.525	-2.005
II	Oct. 25 - Nov. 7	-10.745	-7.70	-1.80	0.055
Q	Nov. 8 - Dec. 17	-3.675	-0.12	-0.305	-4.30
Q	Dec. 18 - Jan. 23	-0.30	-0.41	-0.78	-0.825
III	Jan. 24 - Feb. 19	-21.10	-7.775	-6.84	-7.415
Q	Feb. 20 - Apr. 15	-2.40	0.64	-4.125	1.21
IV	Apr. 16 - May 12	-17.45	-6.91	-1.385	-6.095
R	May 13 - June 2	11.70	5.50	2.92	5.90
V	June 3 - July 31	-21.25	-6.78	-5.665	-7.155
Q	Aug. 1 - Sept. 26	0.985	2.135	-5.85	3.28

Notes: See after Table 2.

TABLE 2

Contemporaneous Correlation of Exchange Rate Intra-day Changes
Yen, DM, UK,

		Tokyo		Europe		New York	
		Yen	DM	Yen	DM	Yen	DM
I 9/23 - 9/30	DM	.84		.93		.72	
	UK	.36	.55	-.51	-.33	.74	.97
Q 10/1-10/24	DM	.75		.61		.96	
	UK	.65	.80	.27	.65	.56	.63
II 10/25-11/7	DM	.52		.69		.92	
	UK	.20	.70	.63	.72	.85	.94
Q 11/8-12/17	DM	.42		.59		.76	
	UK	.41	.32	.48	.57	.70	.83
Q 12/18-1/23	DM	.44		.63		.93	
	UK	.34	.69	.34	.27	.74	.87
III 1/24-2/19	DM	.81		.71		.78	
	UK	.28	.07	.06	.32	.31	.43
Q 2/20-4/15	DM	.40		.76		.50	
	UK	.29	.33	.52	.53	.40	.50
IV 4/16-5/12	DM	.82		.84		.88	
	UK	.81	.85	.58	.84	.70	.88
R 5/13-6/2	DM	.73		.77		.87	
	UK	.11	.61	.72	.82	.78	.87
V 6/3 - 7/31	DM	.47		.76		.58	
	UK	.28	.05	.11	.10	.85	.36
Q 8/1 -9/26	DM	.85		.82		.75	
	UK	.31	.30	.41	.47	.37	.39

Notes: See next page.

Notes for Tables

(i) Total change is defined as the change from the N.Y. closing of the last day of the preceding regime to the last day of the current regime with two exceptions. Exceptions: G5 regime is the change from the N.Y. closing on September 20, Friday, to the N.Y. opening of September 23, Monday. Note that the Tokyo market was closed on September 23, due to a banking holiday. The total change in the first regime is defined as the chnage from the opening of N.Y. market on September 23 to the N.Y. close of September 30.

(ii) The daily change in the Tokyo market is defined as the yen/$ change from the N.Y. close of the preceding business day to the Tokyo close of the day. The daily change in the European market is defined as the yen/$ change from the Tokyo close to the New York opening of the day. The daily change in the New York market is defined as the yen/$ change from the New York opening to the New York close of the day.

The accumulated changes in a regime is the sum of the daily changes in the respective regime. Due to country-specific banking holidays, the four market changes do not add up to the total change of the regime.

(iii) The regime names, I, II, III, IV and V stand for waves of yen appreciation, and R for reversing period; and Q for a relatively calm spell.

(iv) For table 2: Changes in Yen/$, DM/$ and UK/$ in the specific market everyday are measured in the same manner as Table 1. Then the correlation matrix is calculated for each regime, each market.

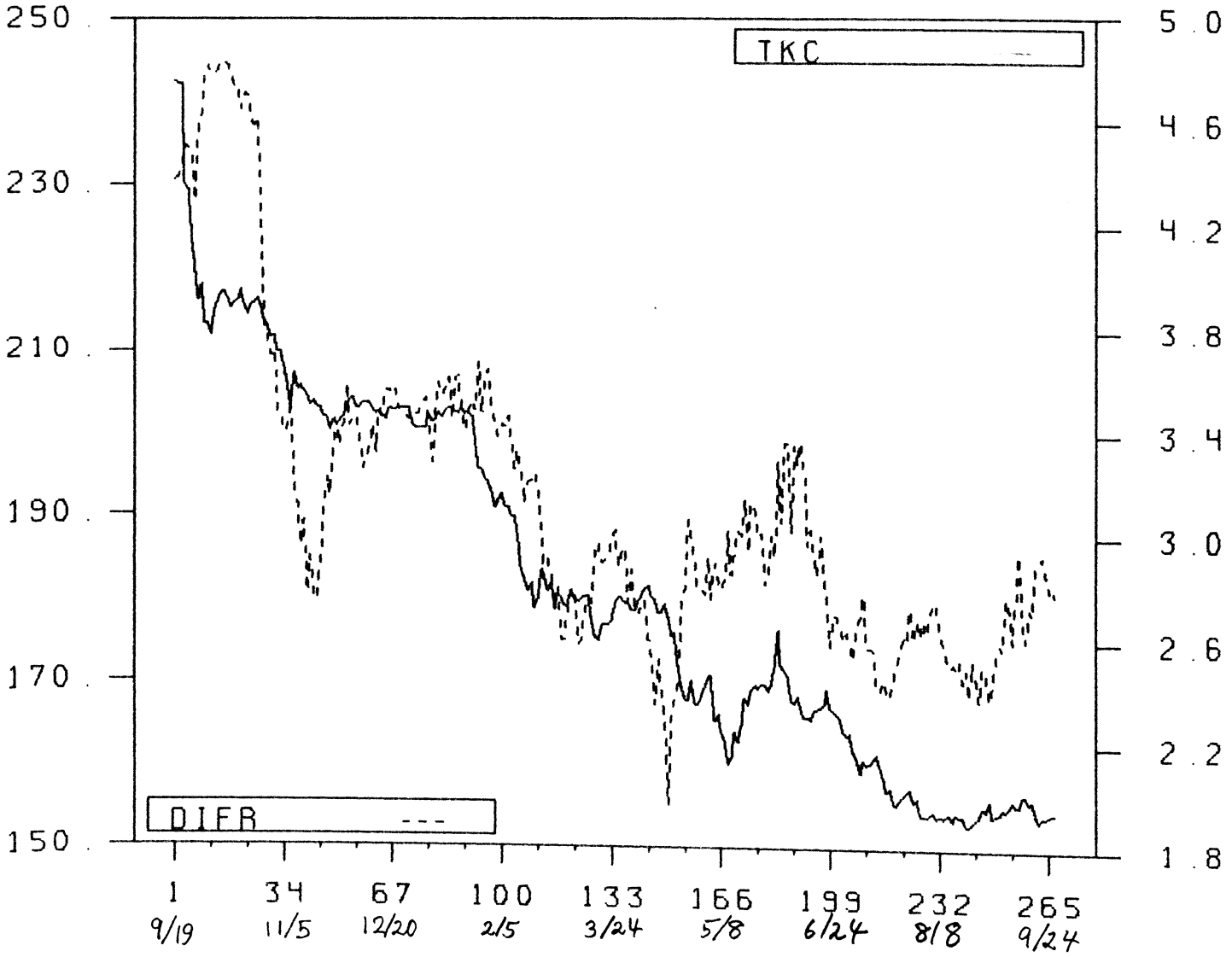


FIGURE 3

TKC: The yen/$ exchange rate (solid line, left scale): The closing rate in the Tokyo market.

DIFR: The interest rate difference in the Japanese long-term government bonds and the U.S. long-term government bonds = USLR - JALR

See NOTES for precise definitions of USLR and JALR.

NOTES to FIGURE 3:

JALR: The yield of the government bonds with about 9 year to maturity in Japan. An average of bid and ask rate [Tentou Kehai uri, kai]. From September to December 1985, Bond #68, maturing in December 1994, with 6.8% coupon rate, is chosen. From January to September 1986, Bond #78, maturing in July 1995, with 6.2% coupon rate, is chosen. In Japan, the long-term government bond market is not comparable to the United States. The ten-year bond is issued by negotiation between the Ministry of Finance and a syndicate of financial institutions. Therefore, the longest maturity with market determined rate is the secondary market with 9 or more years. Moreover, there is a custom to create "designated standard" bonds, which are widely traded and yield significantly lower than others with comparable maturity. Since bonds other than the designated bonds have a thin market, we choose the rate of designated bonds.
Source: Nihon Keizai Shinbun, daily.

USLR: The ten-year government bond rate in the United States, quoted at 4:30 pm, New York time.
Source: T[illegible]ai Data.

TABLE 3
Table of estimates and (t-statistics) by OLS.

LHS variable: YEN changes in the New York Market
Sample period: September 24, 1985 - September 26, 1986.

ALL SAMPLES

period (#OBS)	RHS var. interest rate	stock prices	oil prices	-2 R	DW
all (253)	.917 (2.40)*			.01	2.01
all (241)		-.051 (-1.60)		.00	2.01
all (257)			.005 (0.24)	.00	2.08
all (241)	.704 (1.74)*	-.031 (-0.91)	.004 (0.52)	.01	2.03

SAMPLE SPLIT (REGIME BY REGIME ESTIMATION)

Phase (#OBS)	Dates	RHS variables interest rate	-2 R	DW
I&Q (22)	Sep.23 - Oct.24	5.94 (1.97)*	.08	1.48
II (10)	Oct.25 - Nov.7	1.41 (0.45)	.02	2.33
Q (50)	Nov.8 - Jan.23	1.26 (2.20)*	.06	2.16
III (18)	Jan.24 - Feb.19	2.48 (0.86)	-.14	1.92
Q (38)	Feb.20 - Apr.15	1.30 (1.75)	.07	2.17
IV (13)	Apr.16 - May 12	-0.23 (-0.16)	-.12	1.59
R (20)	May 13 - June 2	0.22 (0.18)	-.02	1.59
V (42)	June 3 - July 31	1.34 (1.29)	-.00	2.12
Q (40)	Aug.1 - Sept.26	-0.12 (-0.15)	-.03	2.51

Notes for TABLE 3.

YEN: percentage change of yen/$ in New York market
= 100*(NYC(t)-NYO(t))/NYO(t)

NYO(t): Openning (9:15am) quote of the Yen/$ rate.
NYC(t): Closing (4:30pm) quote of the Yen/$ rate.
Source: Federal Reserve Bank, New York.

interest rate: (level) change in the long-term U.S. interest rate in the New York market.
= USLRC(t)-USLRO(t)

USLRO(t): Openning (9:15am) quote of 10-yr U.S. gov't bond
USLRC(t): Closing (4:30pm) quote of 10-yr U.S. gov't bond
Source: Technical Data.

stock prices: percentage change in the S&P 500 stock prices over one business day.
= 100*(SP(t)-SP(t-1))/SP(t-1)

SP(t): S&P 500, stock price index. Closing of the day.
Source: Data Resources Inc.

oil prices: percentage change in the oil prices over one business day.
= 100*(OIL(t)-OIL(t-1))/OIL(t-1)

OIL(t): the spot price of the Ninian Blend (London).
Source: Data Resources Inc.

Footnotes

1. The news analysis has been applied to the exchange rate movement in Engel and Frankel (1984) and Frankel (1984; ch.7). The news analysis with the intra-daily exchange rate data was first done by Ito and Roley (1986), which analyzed the movement from 1980 up to the G5 meeting in Septermber 1985. This paper is a direct sequel of Ito and Roley (1986).

2. It is possible to define changes in the "Pacific" market (from the closing of the New York to the opening of the Tokyo market) and changes in the strict Tokyo market (from the opening to the closing of the Tokyo market) separately, in place of the Tokyo market as defined here. However, Ito and Roley (1986) convincingly showed that there is very little news happening to cause exchange rate changes in the "Pacific" market. Practically the New York closing is used as the Tokyo opening. Aggregating the "Pacific" and strict Tokyo market does not do any harm to our analysis.

3. In fact, the Bahrain market, which is open on Sundays, was the first market after the G5 agreement. It was reported that American banks started selling the dollars in the Bahrain market on Sunday, September 22, but no quotes were reported.

4. This same quote was translated as "Nations industry could live with the dollar valued at 190 yen" (Wall Street Journal, January 27, 1986.) Note that the Japanese version states the broadly-defined 190s, with a connotation that it does not go too far below 200, while the English version states 190 as level. The development in the Europe and New York later in the same day was closer to the English version. The point,

however, was that it signaled the switch of the policy.

5. Although the Gramm-Rudman Act was found "unconstitutional" in a Federal Court on February 7, the Congress made efforts to trim federal deficits in the budgeting process. The market must have become more and more convinced during the spring of 1986 that efforts for reducing federal deficits would be more intensified in the near future whether or not the Gramm-Rudman Act is constitutional. However, I could not pinpoint specific events which would prove this conjectures.

6. Nihon Keizai Shinbun carried a story on April 25 about how Japanese investments became "diversified" into European securities. However, a security company source indicated that the "diversification" started in the beginning of April.

7. Later we learned that there was a split of opinions (and a power struggle) within the Federal Reserve Board of Governors. An anti-Volker faction was said to have outvoted Chaiman Volker on February 24 in an attempt to cut the discount rate (without international coordination). However, one member changed position and delayed the rate cut until March 7. (See for example the Wall Street Journal, Editorial, on March 20 for details.) On March 21, the leader of anti-Volker group, Vice Chairman Preston Martin resigned. Since even with coordination, the dollar depreciated heavily after the rate cut, it was a wise decision, at least as afterthought, to delay it, from the viewpoint of the exchange rate stabilization.

8. The discount rates in Japan, the United States and Great Britain were

cut by 0.5% on Monday, April 21. The rumor had been around for a few weeks. But information about the decision became known (leaked?) to the market on April 16 or 17. The decision was formally made and announced on April 18 in the United States and in Great Britain and on April 19 in Japan.

9. The Japanese monetary authorities might have believed in the power of the coordinated interventions, since they reportedly sought after a pledge from other countries to coordinated interventions in the Tokyo summit.

10. The foreign exchange market which is sensitive to what cabinet members and central bankers sayhas been dubbed in Japan as a "political market" (Seiji souba). A column was written about a "political market" in Nihon Keizai Shinbun on as early as February 2. When monetary authorities are talking about the target level of the exchange rate without real interventions, it is dubbed as "all-talk interventions" (Kuchisaki kainyu) in Japan.

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